# STEVAL-L9026 evaluation board user manual

## Introduction

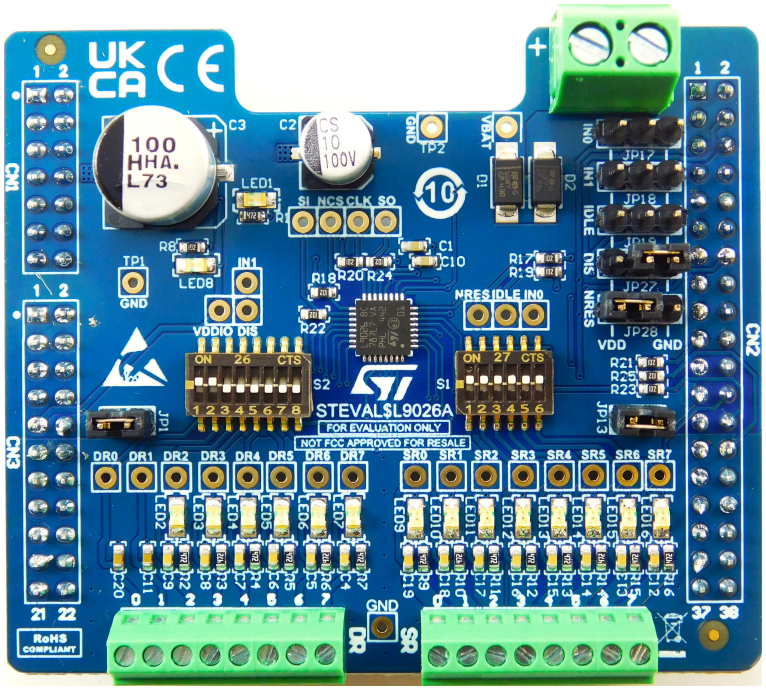
The STEVAL-L9026 is a tool designed to evaluate the L9026 smart power device, designed by STMicroelectronics in advanced BCD technology. The L9026 is an 8-channel IC with 2 fixed HS drivers and 6 configurable HS/LS drivers designed for automotive applications (LEDs and relays) and compatible with resistive, inductive, and capacitive loads. The device offers advanced diagnostic and protection functionalities such as short to GND, open load, overcurrent, and overtemperature detection. The 8 output channels can be driven by SPI or by 2 dedicated parallel inputs that can be associated to different output thanks to a programmable internal multiplexer. Limp home functionality is also featured, which allows the use of 2 selected drivers in specific fault conditions, such as SPI fault, microcontroller fault, or supply UV. Daisy chain compatibility even with 8-bit SPI is available. The device is able to ensure operation in cranking scenarios down to VBATT = 3 V and very low quiescent current in the SLEEP condition.

A serial peripheral interface (SPI) is used for control and configuration of the loads as well as of the device. Status feedback of all diagnostic functions is also provided.

Thanks to the expansion connectors, the STEVAL-L9026 allows the complete control of L9026 communication interface (SPI) and parallel input/output.

The evaluation platform may be completed with an MCU board (AEK-MCU-C1MLIT1), which can be plugged on the STEVAL-L9026 and configured using its dedicated graphical user interface (GUI).

**Figure 1. STEVAL-L9026 evaluation board**




*Notice:* *For dedicated assistance, submit a request through our online support portal at **www.st.com/support**.*

# 1 Hardware description

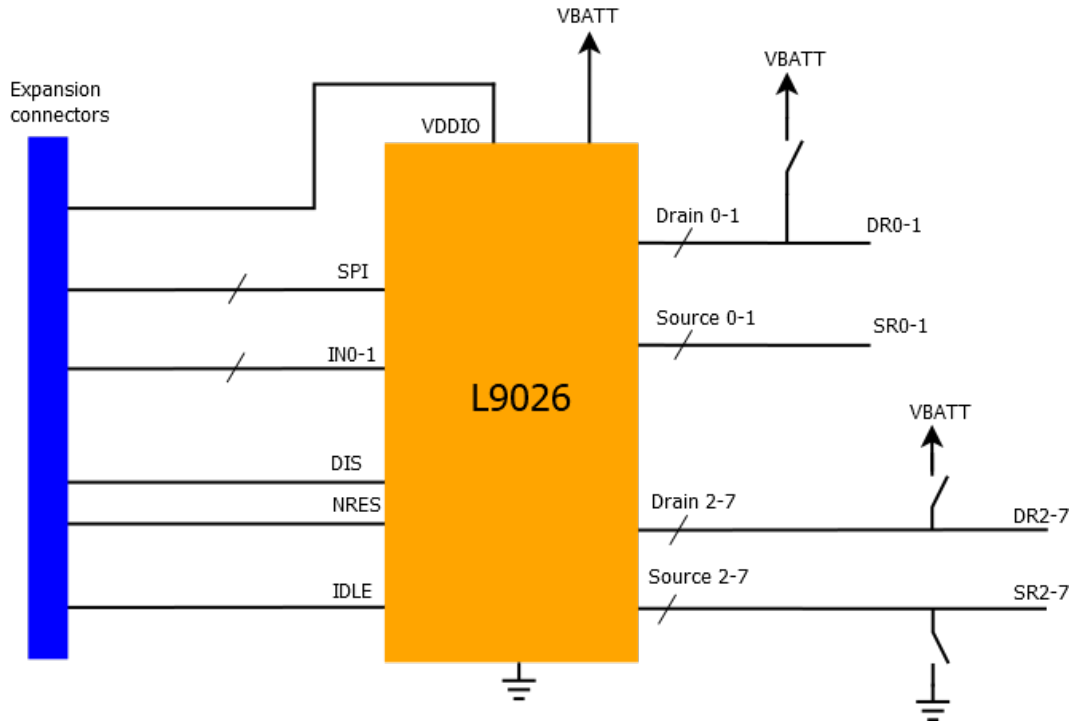
The STEVAL-L9026 is intended as a tool to evaluate all the functionalities of L9026. An optimized BOM has been dimensioned considering the real automotive application range.

The main board characteristics are the following:

- Operative input voltage: 3 - 28V (for VBATT pin)
- Operative input voltage: 3 - 5V (for VDDIO pin)
- 6 configurable HS/LS drivers up to 0.5 A each
- 2 HS drivers up to 0.5 A
- Configurable inputs (using jumpers):
  - IN0/IN1
  - IDLE
  - NRES
  - DIS
- Configurable dip switch for all the L9026 available configurations
- SPI communication interface
- 70 x 59.8 mm 4-layer PCB

## 1.1 Block diagram

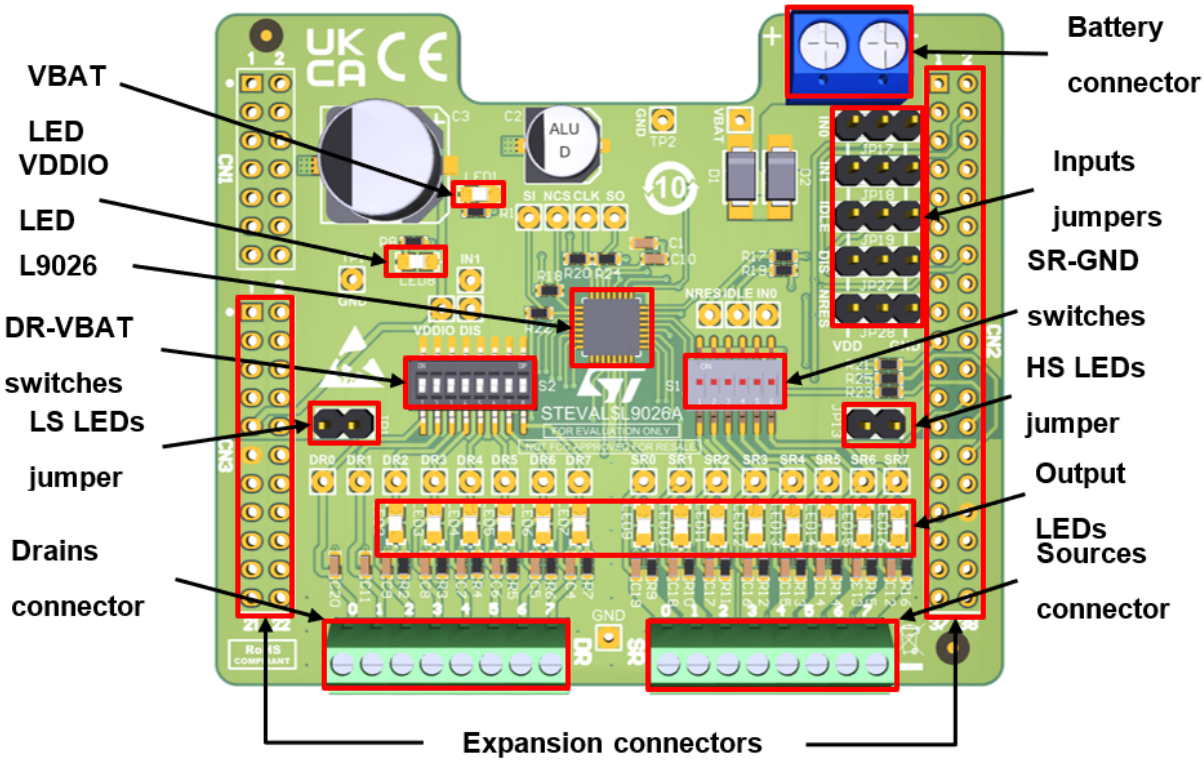
**Figure 2. STEVAL-L9026 block diagram**



# 2 Board description

## 2.1 Evaluation board main components and connectors

Figure 3. **Evaluation board main components and connectors**



## 2.2 Connectors

**Table 1. Evaluation board connectors and switches**

| Name | Description | Type |
|---|---|---|
| CN2 | Expansion connector<br>Pin 4: L9026 NRES<br>Pin 6: L9026 SPI chip select<br>Pin 9,10,20,32: GND<br>Pin 14: L9026 IDLE<br>Pin 19: L9026 DIS<br>Pin 24: L9026 SPI input<br>Pin 26: L9026 IN1<br>Pin 28: L9026 IN0<br>Pin 29: L9026 SPI output<br>All the other pins are unconnected | 19 x 2 header |
| CN3 | Expansion connector<br>Pin 5: L9026 SPI clock<br>Pin 6, 11: GND<br>Pin 9: L9026 VDDIO<br>All the other pins are unconnected | 11 x 2 header |
| J1 | Drains connector<br>Pin 1: drain 7<br>Pin 2: drain 6<br>Pin 3: drain 5<br>Pin 4: drain 4<br>Pin 5: drain 3<br>Pin 6: drain 2<br>Pin 7: drain 1<br>Pin 8: drain 0 | 8 x screw connector |
| J2 | Main battery connector<br>Pin 1: L9026 VBATT<br>Pin 2: GND | 2 x screw connector |
| J58 | Sources connector<br>Pin 1: source 7<br>Pin 2: source 6<br>Pin 3: source 5<br>Pin 4: source 4<br>Pin 5: source 3<br>Pin 6: source 2<br>Pin 7: source 1<br>Pin 8: source 0 | 8 x screw connector |
| S1 | High/Low side configuration (Source)<br>Open: sourcen is connected to J58_sourcen; n=2..7 (HS configuration)<br>Closed (default): sourcen is connected to GND; n=2..7 (LS configuration) | 6 x dip switches |

| Name | Description | Type |
|---|---|---|
| S2/1 | Open: drainn is connected to J1_drainn; n=0, 1<br>Closed(default): drainn is connected to VBAT; n=0, 1 | 8 x dip switches |
| S2/2 | High/Low side configuration (Drain)<br>Open (default): drainn is connected to J1_drainn; n=2..7 (LS configuration)<br>Closed: drainn is connected to VBAT; n=2..7 (HS configuration) | |

## 2.3 Jumper configurations

**Table 2. Evaluation board jumper configuration**

| Name | Description | Default configuration |
|---|---|---|
| JP1 | LS outputs LEDs switch<br>Closed → LS output LEDs active<br>Open → LS output LEDs inactive | CLOSED |
| JP13 | HS outputs LEDs switch<br>Closed → HS output LEDs active<br>Open → HS output LEDs inactive | CLOSED |
| JP17 | IN0 switch<br>Closed in position 1-2 → IN0 = 5 V<br>Closed in position 2-3 → IN0 = 0V<br>Open → IN0 driven by GUI | OPEN |
| JP18 | IN1 switch<br>Closed in position 1-2 → IN1 = 5 V<br>Closed in position 2-3 → IN1 = 0V<br>Open → IN1 driven by GUI | OPEN |
| JP19 | IDLE switch<br>Closed in position 1-2 → IDLE = 5 V<br>Closed in position 2-3 → IDLE = 0V<br>Open → IDLE driven by GUI | OPEN |
| JP27 | DIS switch<br>Closed in position 1-2 → DIS = 5 V<br>Closed in position 2-3 → DIS = 0V<br>Open → DIS pin floating | CLOSED (position 2-3) |
| JP28 | NRES switch<br>Closed in position 1-2 → NRES = 5 V<br>Closed in position 2-3 → NRES = 0V<br>Open → NRES pin floating | CLOSED (position 1-2) |

*Note: Jumpers JP1 and JP13 must be left open for open load diagnosis.*

# 3 Getting started

## 3.1 Minimum setup

In order to operate the STEVAL-L9026, the following equipment is necessary:

- VBATT power supply 3 - 28 V current capability up to 8 A
- VDDIO power supply 3 - 5 V (only if AEK-MCU-C1MLIT1 is not used)
- Loads: LED, relay, lamp with a rating of 12 V, 0.5 A
- Optional: AEK-MCU-C1MLIT1 and STEVAL-L9026 GUI.

For AEK-MCU-C1MLIT1 board usage, please refer to the relevant user manual.

## 3.2 Startup

Follow the steps below before using the board, :

**Step 1.** Configure S1 and S2 dip switches according to Table 1 or according to your preferred setup.

**Step 2.** Configure the power supply to the desired voltage level and limit the current to “n x 1A”, where n is the number of connected loads.

**Step 3.** Switch the power supplies on and check that VBATT LED and VDDIO LED are switched on.

**Step 4.** Check the IDLE input and SPI settings according to the L9026 datasheet.

**Step 5.** Check IN0 and IN1 according to your setup.

**Step 6.** Check that output LEDs switch on correctly when the linked output is switched on.

## 3.3 Usage example

In this section, a usage example is described, according to the configuration provided in the following table.

**Table 3. Example configuration**

| Channel | Configuration | Load | Associated control |
|---|---|---|---|
| CH0 | HS | Solenoid actuator | IN0 |
| CH1 | HS | (unconnected) | SPI |
| CH2 | LS | LED | LED PWM generator |
| CH3 | HS | Resistive load | GEN PWM generator |
| CH4 | LS | Bulb lamp | SPI |
| CH5 | LS | Relay | IN1 |
| CH6 | LS | (unconnected) | SPI |
| CH7 | LS | (shorted to GND) | SPI |

**Table 4. S1 and S2 configuration**

| Switch name | Associated output | Position | Configuration |
|---|---|---|---|
| **S1** | | | |
| S1.1 | Source2 | Closed (connected to GND) | LS |
| S1.2 | Source3 | Open | HS |
| S1.3 | Source4 | Closed (connected to GND) | LS |
| S1.4 | Source5 | Closed (connected to GND) | LS |
| S1.5 | Source6 | Closed (connected to GND) | LS |
| S1.6 | Source7 | Closed (connected to GND) | LS |
| **S2** | | | |
| S2.1 | Drain0 | Closed (connected to VBAT) | HS |
| S2.2 | Drain1 | Closed (connected to VBAT) | HS |
| S2.3 | Drain2 | Open | LS |
| S2.4 | Drain3 | Closed (connected to VBAT) | HS |
| S2.5 | Drain4 | Open | LS |
| S2.6 | Drain5 | Open | LS |
| S2.7 | Drain6 | Open | LS |
| S2.8 | Drain7 | Open | LS |

Startup phase:

**Step 1.** Power up the system

With the load configuration given in Table 3, if JP1 (LS LEDs jumper) is closed, the output LED of CH7 will switch on since drain 7 is shorted to GND.

**Step 2.** IN0 = 0, IN1 = 0, IDLE = 0. The device is in **sleep** mode

**Step 3.** IN0 = 0, IN1 = 0, IDLE = 1. The device is in **idle** mode

**Step 4.** SPI initial configuration:

- **CFG_0: 0X8420** (configure CH3 as HS, all other outputs are in default state LS, frame counter = 0))
- **MAP_IN0: 0x9C05** (associate IN0 to CH0, frame counter = 1)
- **MAP_IN1: 0xA080** (associate IN1 to CH5, frame counter = 0)
- **CFG_1: 0x8803** (LED PWM generator freq = 122.5Hz, frame counter = 1)
- **CFG_2: 0x8C00** (GEN PWM generator freq = 122.5Hz, no adjustment, frame counter = 0)
- **PWM_LED_DC: 0xB001** (PWM LED duty cycle = 0%, frame counter = 1)
- **PWM_GEN_DC: 0xAC02** (PWM GEN duty cycle = 0%, frame counter = 0)
- **MAP_PWM: 0xA431** (CH2-CH3 driven by internal PWM generators, frame counter = 1)
- **PWM_SEL: 0xA812** (CH2 driven by PWM LED & CH3 driven by PWM GEN, frame counter = 0)
- **BIM: 0x9041** (activate bulb inrush mode on CH4, frame counter = 1)
- **CFG_1: 0x8900** (put device in **active mode**, frame counter = 0)
- **STA_1:0x4403** (read Status register 1, expected results POR = 1, VDD_UV = 0, VS_UV = 0 MODE = 11: active mode, frame counter = 1)

The implemented SPI protocol provides the answer to a command frame only with the next transmission triggered by the MCU; so, for example, the expected result of this STA_1 read, will be the SDO value of the next STA_0 read.

- **STA_0:0x4000** (read Status register 0, expected results OUT_ON_ERR = 0, OUT_OFF_ERR = 0, frame counter = 0)

**Step 5.** OFF diagnosis:

Before sending the next SPI command, remove jumpers JP1&JP13 otherwise the OUTPUT LED is considered as a load for CH6, masking the open load diagnosis.

- **DIAG_OFF_EN: 0xB7FF** (enable OFF diagnosis on all channels to detect open load or short circuit to GND, frame counter = 1)

Wait at least 1.6 ms to allow the OFF-diagnosis cycle to be completed.

- **STA_0: 0x4000** (read Status register 0: expected result DIS = 0, NRES = 1, IDLE = 1, IN1 = 0, IN0 = 0, OUT_ON_ERR = 0, OUT_OFF_ERR = 1, frame counter = 0)
- **DIAG_OPL_OFF: 0x4C01** (read open load in OFF diagnostic: expected results OUT6=1 and OUT1=1 because unconnected, frame counter = 1)
- **DIAG_SHG: 0x5400** (read short to GND diagnostic: expected results OUT7 = 1 because shorted to GND, frame counter = 0)

After OFF diagnosis completion, jumpers JP1&JP13 can be closed, so there will be visual feedback at channels switch ON.

**Step 6.** Switch ON the loads

- IN0 =1, IN1 = 1 (switch ON CH0 & CH5, through GUI or JP17-JP18)
- **PWM_SPI: 0x9B49** (all SPI driven channels are switched ON, frame counter = 1)
- **PWM_GEN_DC: 0xAFFE** (configure PWM GEN duty cycle at 100 %, the expected effect is CH3 fully ON, frame counter = 0)
- **PWM_LED_DC: 0XB3FD** (configure PWM LED duty cycle at 100 %, the expected effect is CH2 fully ON, frame counter = 1)

**Step 7.** Over current and over temperature diagnosis

- **DIAG_OVC_OVT:0x4802** (read the overcurrent and overtemperature diagnosis, expected results OUT4 = 1 since a bulb lamp has been used; refer to the L9026 datasheet for further details. Frame counter = 0)
- **DIAG_OVC_OVT_RLW: 0XBFFD** (clear all the overcurrent and overtemperature diagnosis, expected result reading again DIAG_OVC_OVT all the diagnosis has been cleared. Frame counter = 1)

Before sending the next SPI commands, remove jumpers JP13 otherwise the OUTPUT LEDs are considered as a load for HS channels, masking the open load diagnosis.

**Step 8.** OPL in ON diagnosis on channels configured as HS:

– **DIAG_OPL_ON_EN: 0xB804** (enable open load in ON diagnosis on ch0, frame counter = 0)

Wait at least 210 ms to allow the OL in ON diagnosis cycle to be completed.

– **DIAG_OPL_ON_EN: 0xB809** (enable open load in ON diagnosis on ch1, frame counter = 1)

Wait at least 210 ms to allow the OL in ON diagnosis cycle to be completed.

– **DIAG_OPL_ON_EN: 0xB820** (enable open load in ON diagnosis on ch3, frame counter = 0)

Wait at least 210 ms to allow the OL in ON diagnosis cycle to be completed.

– **DIAG_OPL_ON:0x5003** (read OL in ON diagnostic; expected result is OUT5 = 1 since unconnected, frame counter = 1)

# 4 PCB layout

Figure 4. **Assembly top**

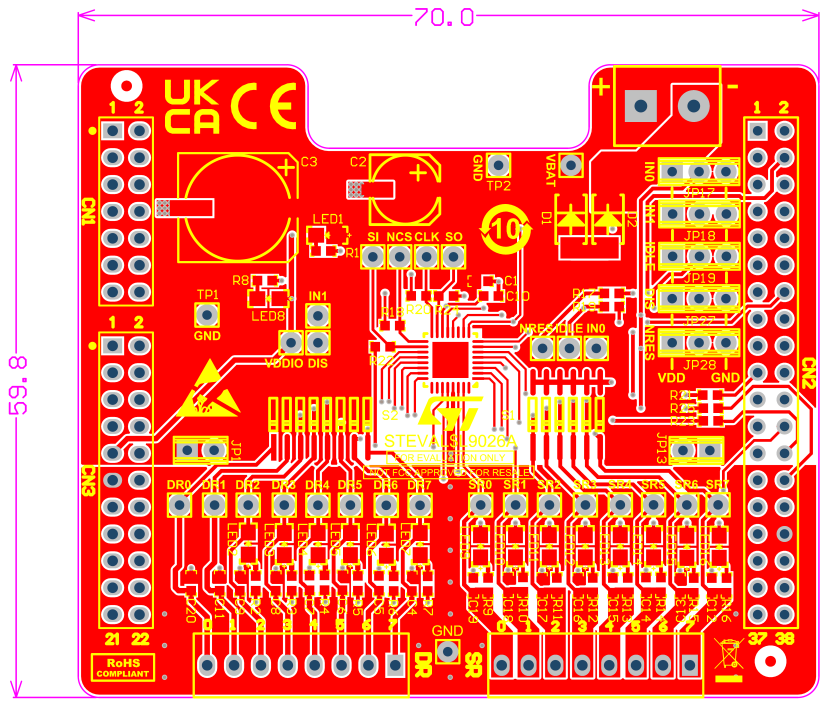



Figure 5. **Inner 1**

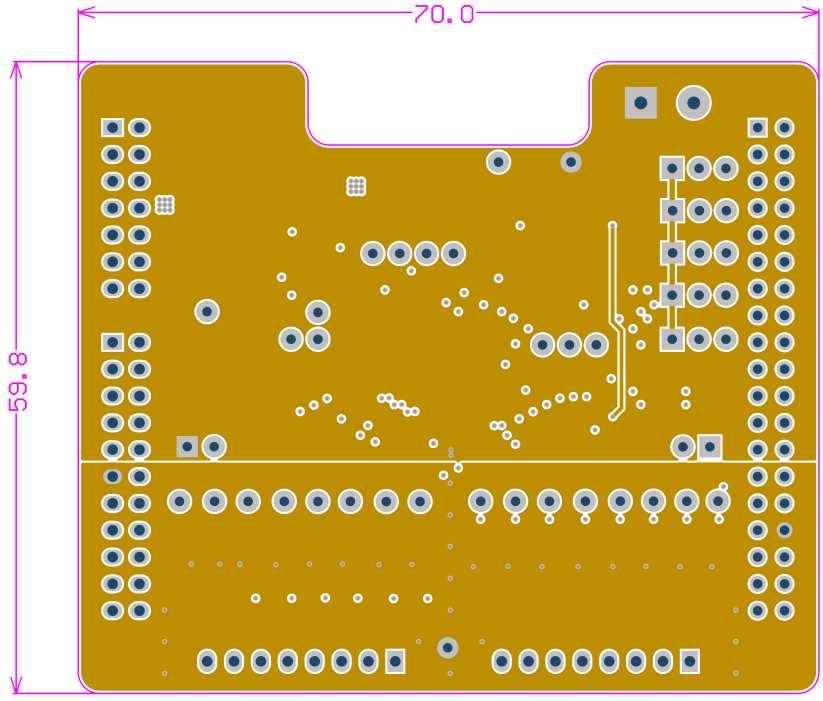


Figure 6. Inner 2

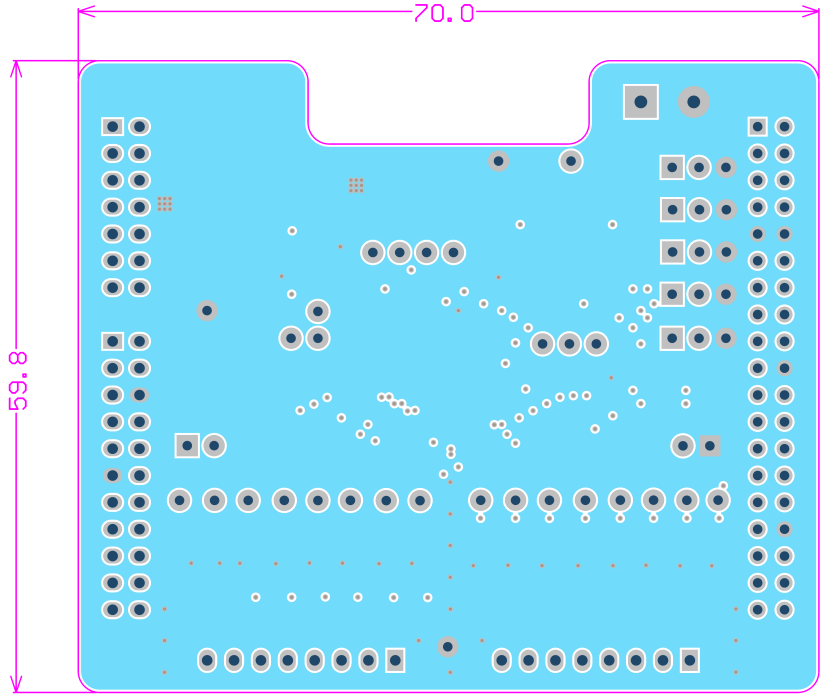
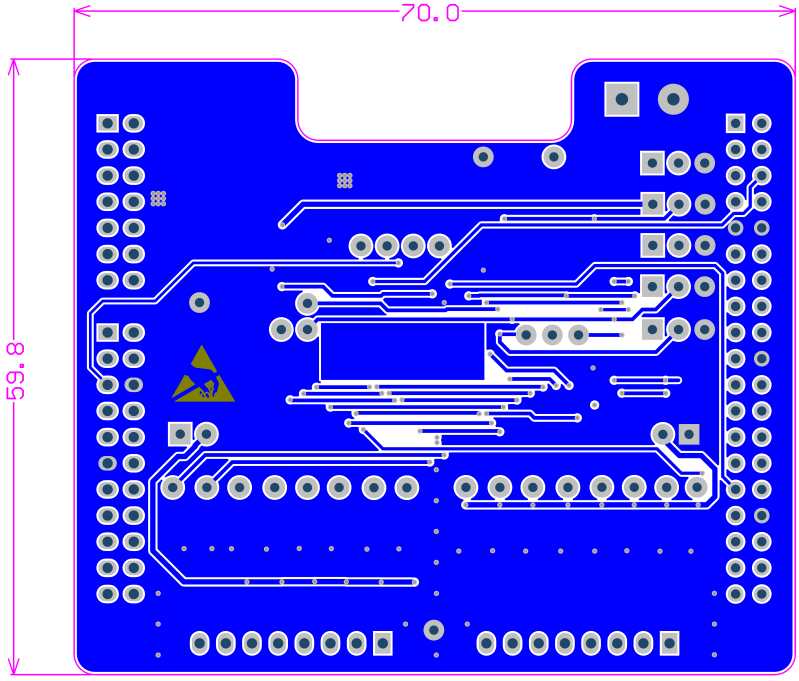
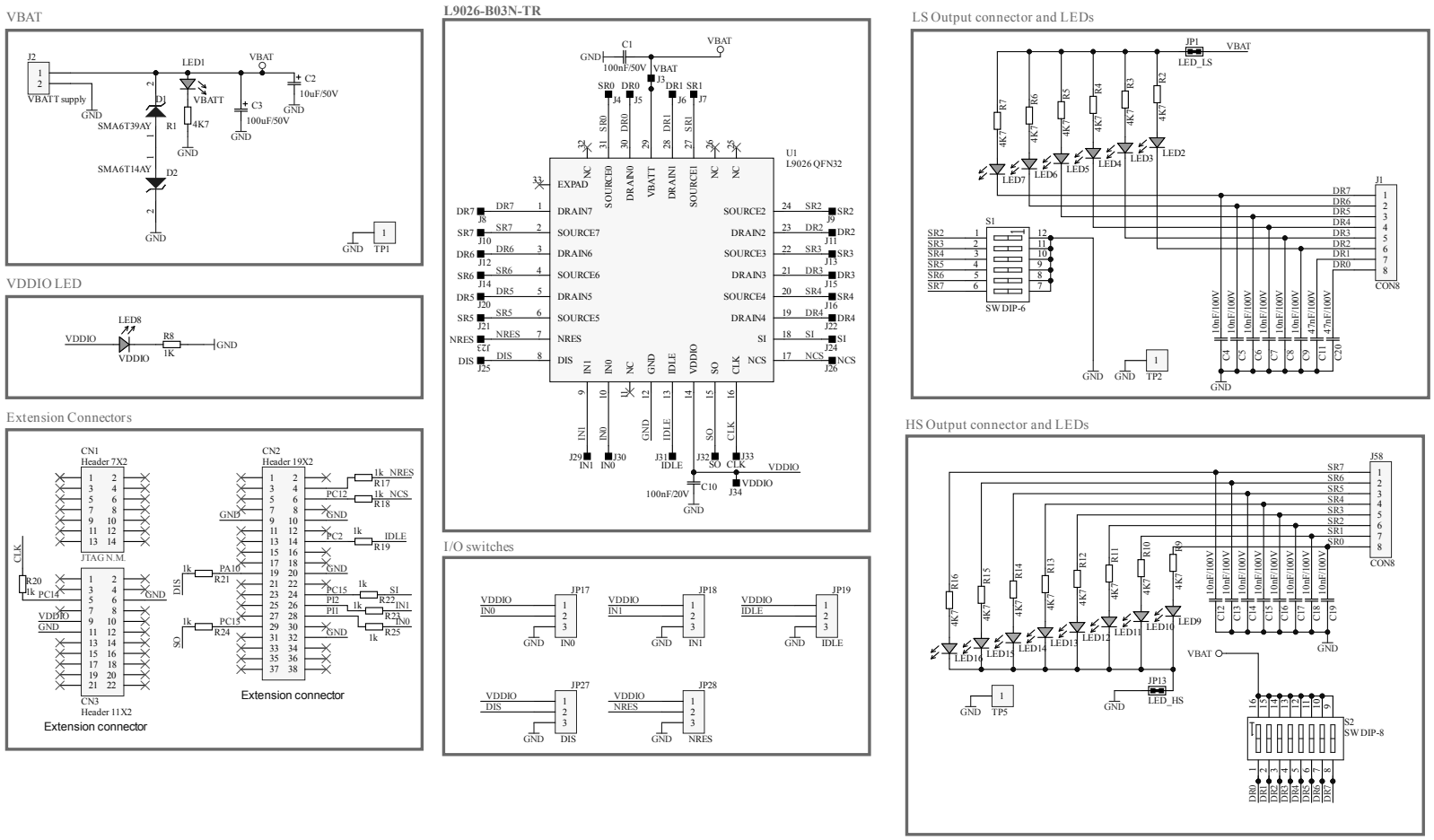



Figure 7. Assembly bottom



# 5 Schematic diagrams

## Figure 8. Evaluation board schematic



# 6 Bill of materials

Table 5. **STEVAL-L9026 bill of materials**

| Item | Q.ty | Ref. | Part/value | Description | Manufacturer | Order code |
|---|---|---|---|---|---|---|
| 1 | 2 | C1 C10 | 100nF | Condensatore ceramico multistrato | WALSIN | 2521529 |
| 2 | 14 | C4 C5 C6 C7 C8 C9 C12 C13 C14 C15 C16 C17 C18 C19 | 10nF | Condensatore ceramico multistrato | VISHAY | VJ0603Y103KXBAC |
| 3 | 1 | C2 | 10uF | Condensatore elettrolitico alluminio | MULTICOMP PRO | MCESL100V106M6.3X7.7 |
| 4 | 1 | C3 | 100uF | Condensatore elettrolitico alluminio | PANASONIC | EEEHA1H101P |
| 5 | 2 | C11 C20 | 47nF | Condensatore elettrolitico alluminio | WALSIN | MT18B473K101CT |
| 6 | 8 | LED9 LED10 LED11 LED12 LED13 LED14 LED15 LED16 | | Led arancione | MULTICOMP PRO | MP007090 |
| 7 | 8 | LED1 LED2 LED3 LED4 LED5 LED6 LED7 LED8 | | Led verde | MULTICOMP PRO | MP005923 |
| 8 | 15 | R1 R2 R3 R4 R5 R6 R7 R9 R10 R11 R12 R13 R14 R15 R16 | 4K7 | Resistor | MULTICOMP PRO | MC0100W060314K7 |
| 9 | 10 | R8 R17 R18 R19 R20 R21 R22 R23 R24 R25 | 1K | Resistor | MULTICOMP PRO | MC0100W060311K |
| 10 | 1 | S1 | SW DIP-6 | Dip switch 6CH SMD | C&K COMPONENTS | TDA06H0SB1R |
| 11 | 1 | S2 | SW DIP-8 | Dip switch 8CH SMD | C&K COMPONENTS | TDA08H0SB1R |
| 12 | 1 | D1, SMA | | Diodo TVS, SMA6TY Transil, unidirezionale | ST | SMA6T39AY |
| 13 | 1 | D2, SMA | | Diodo TVS, SMA6TY Transil, unidirezionale | ST | SMA6T14AY |
| 14 | 1 | CN1 | HDR2X7 | Presa PCB Preci-Dip, 14 vie, 2 file, passo 2.54mm | Preci Dip | 803-87-014-10-001101 |
| 15 | 1 | CN2 | HDR2X19 (2X10) | Presa PCB Preci-Dip, 20 vie, 2 file, passo 2.54mm | Preci Dip | 803-87-020-10-001101 |
| 16 | 1 | CN2 | HDR2X19 (2X9) | Presa PCB Preci-Dip, 18 vie, 2 file, passo 2.54mm | Preci Dip | 803-87-018-10-001101 |
| 17 | 1 | CN3 | HDR2X11 | Presa PCB Preci-Dip, 22 vie, 2 file, passo 2.54mm | Preci Dip | 803-87-022-10-001101 |
| 18 | 2 | J1 J58 | CONN 8 POLI 2.54 | Morsettiera filo-scheda, 2.54 mm, 8 Vie, 26 AWG, 18 AWG, 1 mm², con viti | MULTICOMP PRO | MP008517 |
| 19 | 1 | J2 | CONN 2 POLI | Morsettiera filo-scheda, 5.08 mm, 2 Vie, 28 AWG, 12 AWG, con viti | AMPHENOL ANYTEK | VI0221520000G |

| Item | Q.ty | Ref. | Part/value | Description | Manufacturer | Order code |
|---|---|---|---|---|---|---|
| 20 | 5 | JP17 JP18 JP19 JP27 JP28 | | Connettore a strip maschio, dritto, scheda a scheda, 2.54 mm, 1 File, 3 Contatti | HARWIN | M20-9990345 |
| 21 | 2 | JP1 JP13 | | Connettore a strip maschio, - , scheda a scheda, 2.54 mm, 1 File, 2 Contatti | HARWIN | M20-9990245 |
| 22 | 1 | U1, VFQFPN 5X5X1 32L P0.5 | L9026 | Configurable multi channel relay driver 2HS + 6HS/LS | ST | L9026-B03N-TR |

# 7 Board versions

Table 6. **STEVAL-L9026 versions**

| Finished good | Schematic diagrams | Bill of materials |
|---|---|---|
| STEVAL$L9026A (1) | STEVAL$L9026A schematic diagrams | STEVAL$L9026A bill of materials |

1. *This code identifies the STEVAL-L9026 evaluation board first version.*

# 8 Regulatory compliance information

### Notice for US Federal Communication Commission (FCC)

For evaluation only; not FCC approved for resale

FCC NOTICE - This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine

whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

### Notice for Innovation, Science and Economic Development Canada (ISED)

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

### Notice for the European Union

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2015/863/EU (RoHS).

### Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032).

# 9 Reference documents

[1] STEVAL-L9026 user manual (UM3339)

# Revision history

Table 7. **Document revision history**

| Date | Version | Changes |
|---|---|---|
| 03-Feb-2025 | 1 | Initial release. |

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